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CLEANING GRAIN WITH THE BATES ASPIRATOR

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CLEANING GRAIN WITH THE BATES ASPIRATOR

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DOCKAGE PROBLEM IS FAR-REACHING

Approximately 1,239,000 bushels of dockage was assessable against the 118,665,000 bushels of wheat produced in the Pacific Northwestern States of Washington, Idaho, and Oregon, during a recent year. Of this dockage approximately 764,000 bushels were of smut dockage, estimated from figures gathered from reliable sources.

The question of dockage has become one of the outstanding problems of the wheat belt, and in the Pacific Northwest the dockage situation is complicated by the prevalence of smut. The foreign elements that constitute dockage, like weed seeds, trash, and dust and the smut found in wheat, decrease efficiency in every phase of grain production, handling, and marketing, and cause tremendous loss to the wheat farmers in both labor and money. It is to the farmers' advantage that the dockage and smut balls and smut spores be removed from wheat at the earliest possible point, to eliminate so far as possible the extra cost in handling and transporting the foreign material as a part of the wheat and to obtain the better price usually paid for clean wheat. If dockage is removed at the country elevator it can usually be ground at the elevator and returned to the farmers, or sold to others for feeding purposes. This has three advantages: (1) The cost of handling the dockage is cut off early in the marketing process; (2) the farmers get this feed at a minimum cost, and (3) the country elevator is given a good side line.

The dockage problem concerns many others besides farmers. The explosive quality of the light dust of grain when mixed with air endangers life and property at the threshing machines, mills, and elevators. If the millers do not remove the dockage entirely, the presence of foreign grains or weed seeds in the wheat that is ground for flour usually produces objectionable characteristics in the flour and in the bread made from it. Thus the consumer, too, suffers in lack of quality, and the increased cost of dealing with this dockage in transporting and cleaning tends to increase the cost of flour to consumers.

DIFFERENT KINDS OF DOCKAGE

Dockage in wheat may be grouped in two large classes—foul dockage and smut dockage.

FOUL DOCKAGE

With the advent of the Federal grain standards, dockage in wheat, formerly an indefinite term, was given a very definite meaning, and the method of determining and stating dockage for wheat grading purposes was prescribed. Foreign matter in wheat, such as sand, dirt, weed seeds, weed stems, chaff, straw, grain other than wheat and any other foreign material which can be removed readily from the wheat by the use of appropriate sieves, cleaning devices, or other practical means, is termed "dockage" under the Federal standards. Even small pieces of the wheat kernels and badly shriveled kernels may be classed as dockage, if they can not readily be recovered from the other dockage by properly rescreening or recleaning. This method of determining dockage is kept as nearly uniform throughout the United States as possible by careful Federal supervision of grain grading.

Dockage in wheat varies greatly in kind and amount in different parts of the United States. There are certain weeds and other grains which mature and ripen simultaneously with wheat, which, if present in the field, are naturally harvested and threshed with the wheat. These weed seeds and other grain kernels are often permitted to stay in the wheat used for seed. Such weeds increase from year to year until they become a pest unless especial effort is made to remove all weed seeds and other grain from the seed wheat and from the soil. Some weed seeds and foreign grains are readily separated from wheat because of their difference from wheat in size, shape, or weight. Other seeds, because of their similarity to the wheat kernels, present very perplexing problems in grain cleaning.

SMUT DOCKAGE

In the Pacific Northwest, where wheat is largely raised on semiarid lands, the serious wheat disease known as bunt or stinking smut has increased greatly in spite of all efforts made to check it and presents a very serious and prevalent problem. Smut of wheat is a fungous growth which infests the growing grain. When the wheat ripens, instead of producing a head full of wheat kernels, each kernel is a ball of fine dustlike spores. Because of the similarity in shape and size of these smut balls and of wheat kernels, the balls are not readily removed from wheat.

The smut balls vary in texture from a rather hard, caked consistency to a very light fluffy powder. The hard smut balls persist in the wheat as balls because of their resistance to crushing and their similarity to the wheat. The soft smut balls, readily crushed in the natural handling of the wheat, release millions of dark-colored microscopic seeds or spores which give the wheat a dingy black appearance. When once thoroughly mixed with the wheat this smut dust can not be removed by the ordinary dockage removing machinery. Special equipment is required for the purpose.

Because of the prevalence of this disease in wheat and the difficulty of removing the smut from the threshed grain, a special grading system for smutty wheat is recognized by the Federal grain standards for wheat. In the Federal grain standards smutty wheat is defined thus: "Smutty wheat shall be all wheat which has an unmistakable odor of smut, or which contains spores, balls, or portions of balls, of smut, in excess of a quantity equal to two balls of average size in 50 grams of wheat."

When wheat is graded as smutty wheat under the standards, the grades for smutty wheat are as follows:

> *Grades for smutty wheat.*—Smutty wheat shall be graded and designated according to the method described either in paragraph (*a*) or paragraph (*b*) of this section.
>
> (*a*) Before the determination of smut dockage as provided in this paragraph, the wheat shall be graded and designated according to the grade requirements of the standard applicable to such wheat if it were not smutty, except that smut balls shall not be considered as foreign material other than dockage. The loss in weight caused by the removal of smut from the wheat shall be ascertained by scouring, washing, or otherwise, and shall be calculated in terms of percentage based on the total weight of the grain free from dockage. The percentage so calculated shall be stated in terms of whole per cent and half per cent. A fraction of a per cent when equal to or greater than a half shall be treated as half, and when less than half shall be disregarded. The percentage of the smut dockage so calculated and stated shall be added to the grade designation preceding the statement of dockage, if any.
>
> (*b*) Smutty wheat shall be graded and designated according to the grade requirements of the standard applicable to such wheat if it were not smutty, except that (1) smut balls shall not be considered as foreign material other than dockage, and (2) when the amount of smut present is so great that any one or more of the grade requirements of the grades from No. 1 to No. 5, inclusive, can not be applied accurately, the wheat shall be classified as sample grade. For all grades there shall be added to and made a part of the grade designation, preceding the statement of dockage, if any, the word "smutty."

The method used for grading smutty wheat is optional. Usually when either the *a* or the *b* method is approved by both the farmers and the grain dealers, that method prevails in that particular section of the country. In the Pacific Northwest the *a* method is used almost exclusively. Thus another dockage occurs, known as the smut dockage, and it is computed as a percentage of the weight of the wheat. The smut dockage is computed on the basis of the weight of dockage-free wheat; the dockage for foreign matter is computed on the gross original weight of the wheat including foul dockage.

SMUT DOCKAGE CAUSES TREMENDOUS LOSS

Tremendous loss is caused by smut dockage alone. Estimates based on Oregon State grain inspection figures showed that the assessed smut dockage in wheat coming into Portland, Oreg., during the crop year 1923-24, amounted to approximately 237,107 bushels of 60 pounds each. Figured at a farm value of wheat of 75 cents a bushel, this meant a loss of approximately $177,800. This amount does not represent the total loss to the farmer resulting from smut. There are charges for freight, insurance, interest, storage, handling, increased cost of threshing, and a smutting discount which is a charge for cleaning. Even before that comes the enormous loss through reduction in yield per acre caused by smut.

Reduction in per acre yield caused by smut in the field is the greatest source of loss to the farmers. They are less conscious of this than of other losses, because they never see this lost wheat. They never know what their yields would have been had it not been for smut. It has been conservatively figured by the Grain Investigations Office at Portland, Oreg., from reliable data, that if in any field producing wheat with smut dockage all of the wheat heads that produce smut had produced wheat there would have been an additional 10 bushels of wheat for every bushel of assessed smut dockage. Therefore it is reasonable to conclude that the farmers who raised the wheat that was inspected at Portland, Oreg., in 1923–24 probably lost in reduced yield about ten times what they lost in smut dockage figured as wheat, or about $1,778,000.

Losses from most of the other items are more difficult to estimate; but the expense to the farmer of cleaning this smutty wheat has been computed from inspection records and smut discounts in use by the Pacific Northwest grain dealers to have been over $372,000.

The estimated total loss to farmers on total receipts of 36,824,093 bushels of wheat that came into Portland, Oreg., in 1923–24 was, therefore, more than $2,327,000, made up of (1) smut dockage, figured as wheat, $177,800; (2) reduction of yield in the field, $1,778,000; and (3) charge for smutting the wheat, $372,000. Reduced to a loss per bushel basis this indicates an average loss of 6.32 cents per bushel.

According to the department's estimates of wheat production for the three Pacific Northwest States with an estimated farm value of 75 cents a bushel, this indicates a loss in Oregon of $1,694,202, in Washington of $3,902,157, in Idaho of $1,903,268, and for the Pacific Northwest a total loss for that crop year of more than $7,000,000 by the farmers in one region during one crop year from smut of wheat. If the wheat is valued at $1 a bushel at the farm instead of 75 cents, the total loss in these States amounts to approximately $10,000,000.

PROBLEM COMPLICATED BY SACKED GRAIN

In the Pacific Northwest there is a dual system of handling grain which complicates the dockage-removal problem. Wheat is largely shipped to market in jute bags containing approximately 2¼ bushels each. The grain is placed in these bags at the threshing machine and the bags are neatly sewn. Thus anything which goes into the wheat bag can not be removed economically until the bag of wheat reaches its destination, which is usually the terminal mill or elevator. Therefore it is doubly important that when bags are used all possible assessable dockage and excess foreign material be removed from the wheat at the time of threshing. Removal of smut dockage from sacked grain costs the farmer 30 cents per ton or 0.9 cent per bushel more than the removal of the same smut dockage from bulk grain.

CLEAN SEED AND CLEAN CULTURE WILL HELP

The first point of attack is, of course, to improve the quality and purity of seed and to urge better farm methods of cultivation, so that weeds and foreign grains will not be grown with the grain. If farmers raise clean wheat which is also free from smut in the first place, all the expense and trouble of handling dockage and all the expense and trouble of removing the dockage and smut balls and smut spores will be avoided.

In the Pacific Northwest, where practically all seed wheat is treated for smut before seeding, it is highly desirable to remove as much as possible of the smut dust and balls from the wheat before administering the seed treatment. This can best be done by applying a strong suction of air to the grain at the time of threshing by means of the Bates aspirator described in this circular.

Clean-wheat campaigns have been conducted in the Northwest for the past few years, backed by the United States Department of Agriculture and the States. These campaigns will not fulfill their entire usefulness until they induce cleaner seed and cleaner cultivation.

But the actual production of clean wheat is a long-time proposition. Meanwhile we have the unclean wheat, and the immediate and vital question is how to make this wheat clean at the least expense. To this question the Department of Agriculture is devoting particular attention.

Three lines of attack are now being followed: (1) To urge better cleaning at the thresher with more efficient use of the thresher-cleaning equipment; (2) to extend the use of a recleaner unit that has been developed largely by the Department of Agriculture to accompany threshing machines for the purpose of cleaning out heavy-weight dockage; (3) to extend the use of the Bates aspirator that has been developed by the Department of Agriculture expressly for the purposes of eliminating light-weight dockage and reducing the smut. All of these methods are designed to clean the wheat at or near the farm in order to increase the market and the seed value of the wheat and to hold the expense of accomplishing this as low as possible.

CLEANING BY OTHER METHODS

BY THRESHER

Grain threshers are equipped to clean wheat within reasonable limits, but the problem of grain threshing is essentially a problem of reclaiming as high a percentage as possible of wheat from the straw. The cleaning problem at a thresher is secondary to the thorough threshing and saving of wheat. Many threshermen take pride in being able to clean the threshed wheat thoroughly; but when there is a large amount of dockage in the wheat it is practically impossible to clean the wheat thoroughly with the regular thresher-cleaning equipment.

Naturally a thresherman who is called to thresh a field foul with weeds feels that if he must thresh weeds he should be compensated for his work. When the basis of pay is the weight of the threshed product, the thresherman is naturally not very anxious to separate the weed seeds from the wheat before weighing. Equitable arrangements should be made with threshermen to induce them to clean the grain as much as possible with the thresher equipment. Until the thresherman is paid at least the threshing charge for threshing the dockage, he may be expected to take little interest in the separation of dockage from wheat.

Weeds, especially when green, are run through a threshing machine with great difficulty. The threshing capacity of a machine is much reduced when weeds are threshed with the wheat. In a country where weeds are prevalent the custom threshermen will naturally fix the charge for threshing higher than they would if the wheat were free of weeds. It is obvious, therefore, that in a weed-infested district the farmers must not only pay a higher price per bushel for the gross weight threshed but they must figure the net threshing cost per bushel on the weight of wheat remaining after the weed seeds and dockage are removed. The presence of an abnormal amount of weeds in wheat is always a severe penalty on the thresherman who does not fix his price accordingly. It is thus to the advantage of both the farmer and the thresherman that the farmer should produce wheat free from weeds. By the use of the Bates aspirator described in this circular, light dockage can be cleaned from the grain at the time of threshing at a slight additional cost.

Grain-cleaning machinery built for mill and elevator use consists of stationary machines which, for efficient operation, depend largely on uniformity of working conditions, such as a level position, a uniform flow of grain to the machine, and uniform driving speed. Such machines are usually built for continuous use and are necessarily very heavy and expensive. They are usually built to remove a special kind of foreign grain or material from a special grain and are usually highly efficient for that use. But for these and other reasons, the existing standard grain-cleaning machinery for mills and elevators is not conveniently applied to a threshing machine for recleaning purposes, and the development of machines better adapted to this purpose has thus become a pressing need.

BY PORTABLE CLEANERS

Portable recleaners have been developed by grain-cleaner manufacturers in accordance with designs prepared by the United States Department of Agriculture for cleaning grain at the time of threshing. These cleaners are not attached to the threshing machine, hence are used readily with any threshing machine of the stationary type. Several styles of portable recleaners have been constructed and placed in use. One of them is of a commercial disk type mounted on a separate truck.[1]

Another is a cleaner of the drum type also mounted on a separate truck. Both are self-contained cleaning units, which accompany the thresher and clean the wheat as threshed, or they can be used to clean grain at the farm granary at any time of the year.

A LABORATORY ASPIRATOR

The possibility of cleaning grain by use of air is well shown by the laboratory-size aspirator illustrated in Figure 1. This machine was devised and built by the Office of Grain Investigations of the United States Department of Agriculture for applying air to the cleaning of grain for laboratory sample analysis.

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[1] This machine is described in a mimeographed report (USGSA–GI–21) issued by the U. S. Department of Agriculture, and in several papers read before the American Society of Agricultural Engineers by Robert H. Black. Copy of the report may be had upon application to Bureau of Agricultural Economics, U. S. Department of Agriculture, Washington, D. C.

In cleaning a sample of grain with the laboratory aspirator the rate of feed of the grain and air suction are entirely under control and can be very carefully adjusted to the requirements of the sample.

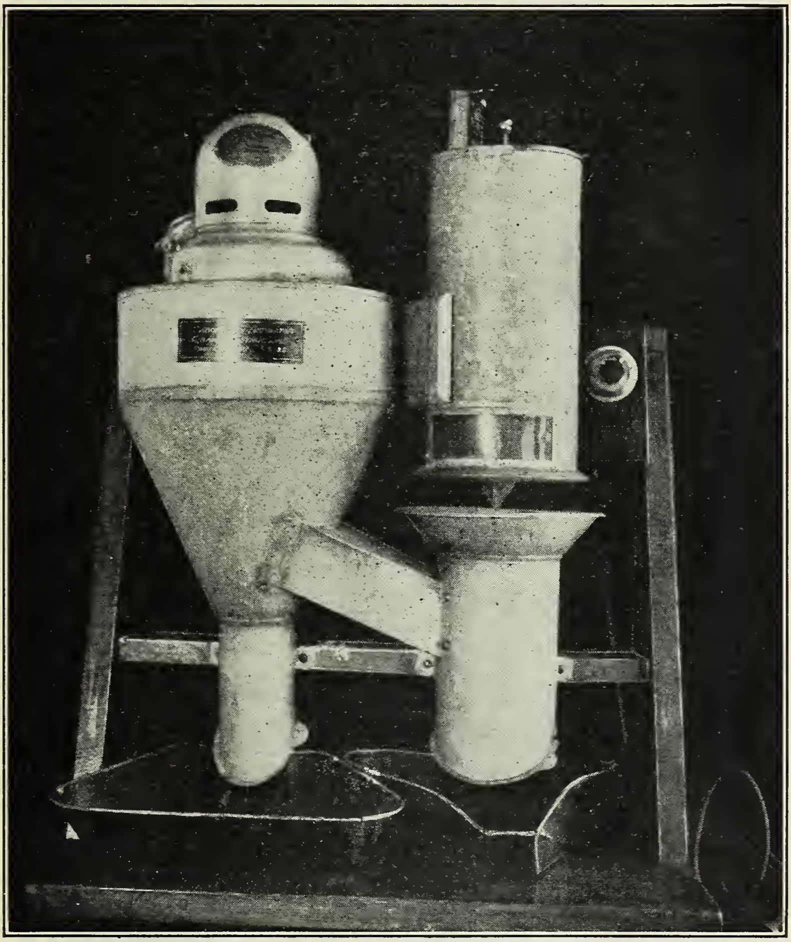

FIG. 1.—Laboratory grain aspirator

The work of cleaning grain can be done more thoroughly with a laboratory aspirator than is possible with the thresher aspirator. Figures 2 and 3 illustrate typical cleaning done by use of a laboratory aspirator.

The laboratory aspirator illustrates what can be done by air in cleaning grain when suction and the flow of grain are most favorable. Such a machine is very useful in any grain laboratory.

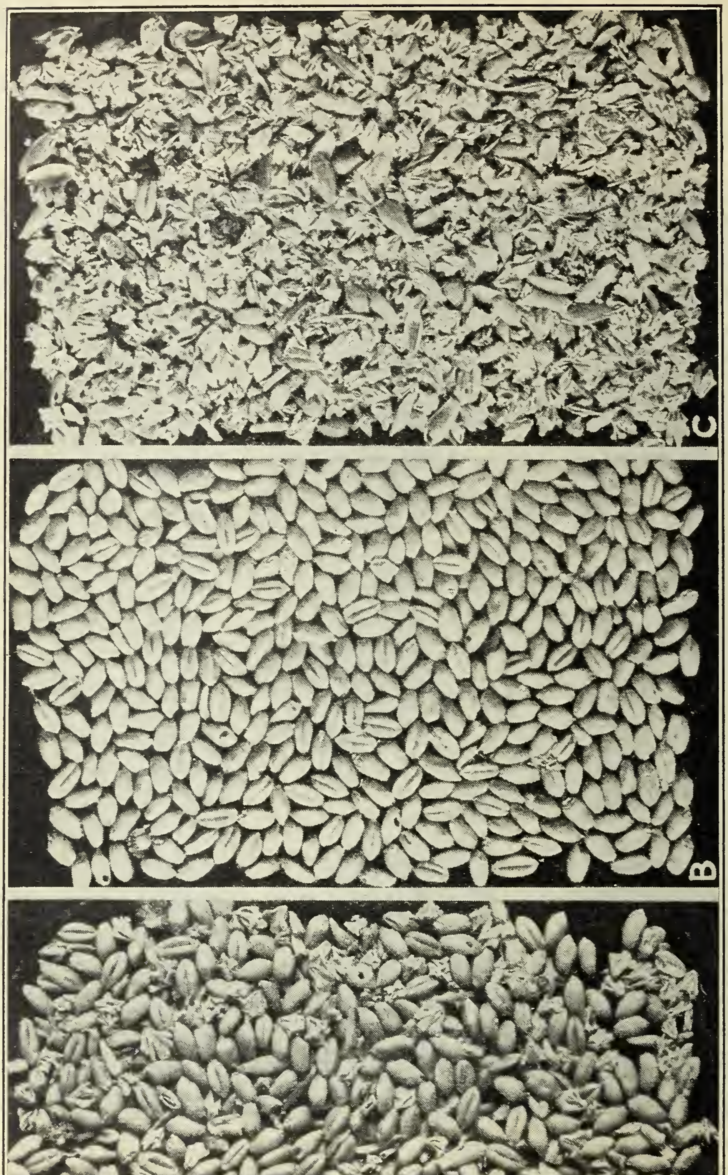

FIG. 2.—Wheat cleaned by laboratory aspirator. (A) California wheat received at the market. (B) Same wheat after being cleaned by the laboratory-size grain aspirator. (C) Type of material removed from the wheat

CLEANING BY THE BATES ASPIRATOR

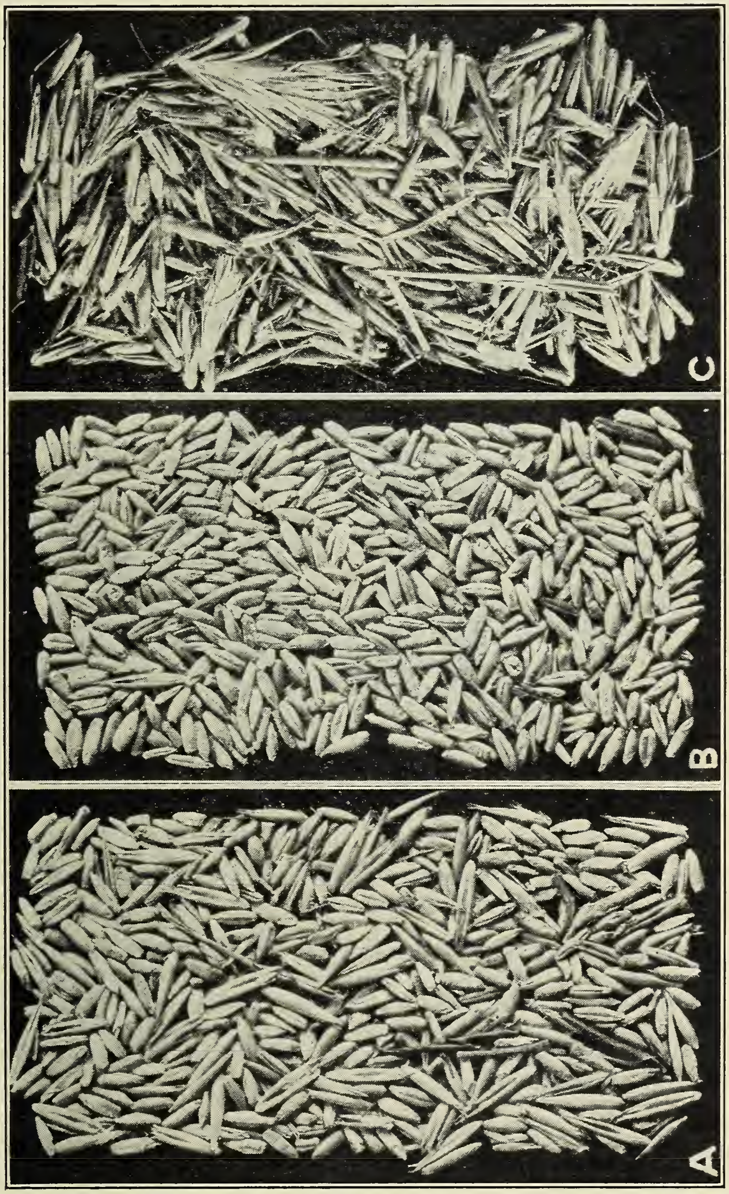

FIG. 3.—Rye cleaned by laboratory aspirator. (A) Rye as received from the farm. (B) Same rye after being cleaned by the laboratory-size grain aspirator. (C) Type of material removed from the rye

For the automatic removal of smut and light dockage from grain at the point of threshing, as a part of the threshing operation, the Department of Agriculture has developed a special type of cleaner called a Bates aspirator. A public patent for the aspirator has been granted to E. N. Bates by the United States Patent Office, which permits the manufacture and use of the patented article by any citizen of the United States without payment of royalty to any person. Figure 4 shows the aspirator attached to a stationary thresher.

The Bates aspirator works on the principle of suction. The grain as it is thrown from the thresher elevator is spread out into a thin, even stream by being directed on to a low inverted cone. The cone is held in such a position as to cause the grain from the elevator to pile up and flow evenly over its edge. A suction from above the pile of grain draws a current of air through the thin sheet of falling grain and lifts from the stream of grain such light material as can be removed by the current of air applied. The grain stream then unites in the funnel below and continues in its normal path. A graphic illustration of the aspirator head is shown in Figure 5. The light material removed from the grain by the air is passed through either a "cyclone" or expansion chamber type of dockage collector, where it is collected and delivered to a convenient point about the thresher to be sacked or otherwise disposed of.[2] By the use of this aspirator the cleaning for dockage and smut becomes a part of the threshing operation. A sectional view of an expansion chamber type of dockage collector is shown in Figure 6.

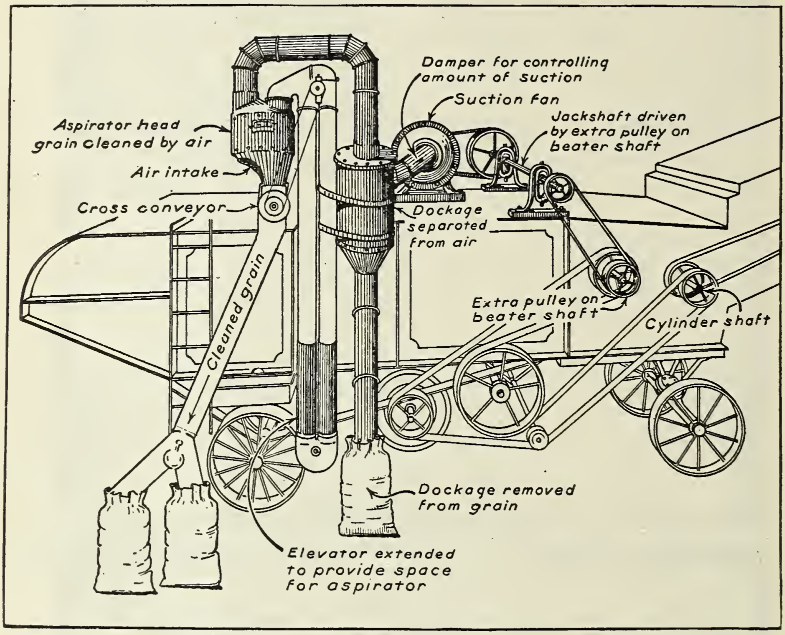
Damper for controlling amount of suction
Suction fan
Jackshaft driven by extra pulley on beater shaft
Aspirator head grain cleaned by air
Air intake
Cross conveyor
Dockage separated from air
Cleaned grain
Extra pulley on beater shaft
Cylinder shaft
Dockage removed from grain
Elevator extended to provide space for aspirator

FIG. 4.—Bates grain aspirator for threshing machine

ADVANTAGES OF ASPIRATOR

Because of the nature of threshing, any attachment added to the already highly-developed mechanism of the threshing machine must be very carefully designed, with attention to all phases of the threshing operation. Cleaners for grain are frequently designed with a very high degree of efficiency for the removal of special kinds of foreign material, but seldom meet the restrictions which must be placed on a cleaner for a threshing machine. These demands are rather rigid for a stationary threshing machine, and they are increasingly severe for the combined harvester for which, as a portable machine, a higher degree of designing skill has been used to make the machine light and compact and yet retain its strength. The aspirator developed by the Department of Agriculture commends itself in many ways as an attachment for a stationary threshing machine and for a combine.

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[2] This aspirator is effective in recleaning other grains than wheat and has been used to advantage in cleaning California rice at time of threshing.

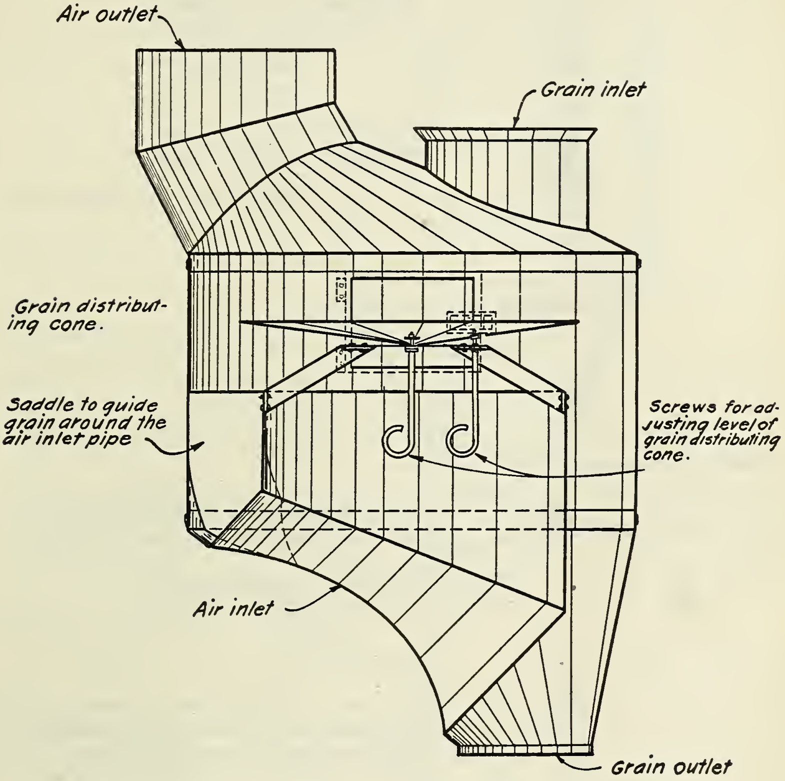
Air outlet
Grain inlet
Grain distributing cone.
Saddle to guide grain around the air inlet pipe
Screws for adjusting level of grain distributing cone.
Air inlet
Grain outlet

Fig. 5.—Cross section of thresher grain aspirator head

It is effective.—The Bates aspirator is effective in removing from grain the smut dust and light foreign material, such as light smut balls, chaff, straw, knuckles, rachis, and many weed seeds. Even the heavier kinds of dockage may be removed to a limited degree by applying a suction sufficient to lift out some of the immature and cracked grain.

It is inexpensive.—Grain-cleaning machinery in general is rather expensive because of the large number of bearings, shafts, and wearing parts. The aspirator is inexpensive compared with other grain-cleaning machinery. The probable expense of the aspirator, dockage collector, and suction fan for a threshing machine of ordinary size should not exceed $150.

It is light.—The aspirator is as light a machine as is consistent with the use to which it is applied. Suction fans vary in weight, depending upon the type used. The aspirator and expansion chamber and a reasonable amount of piping weigh less than 75 pounds.

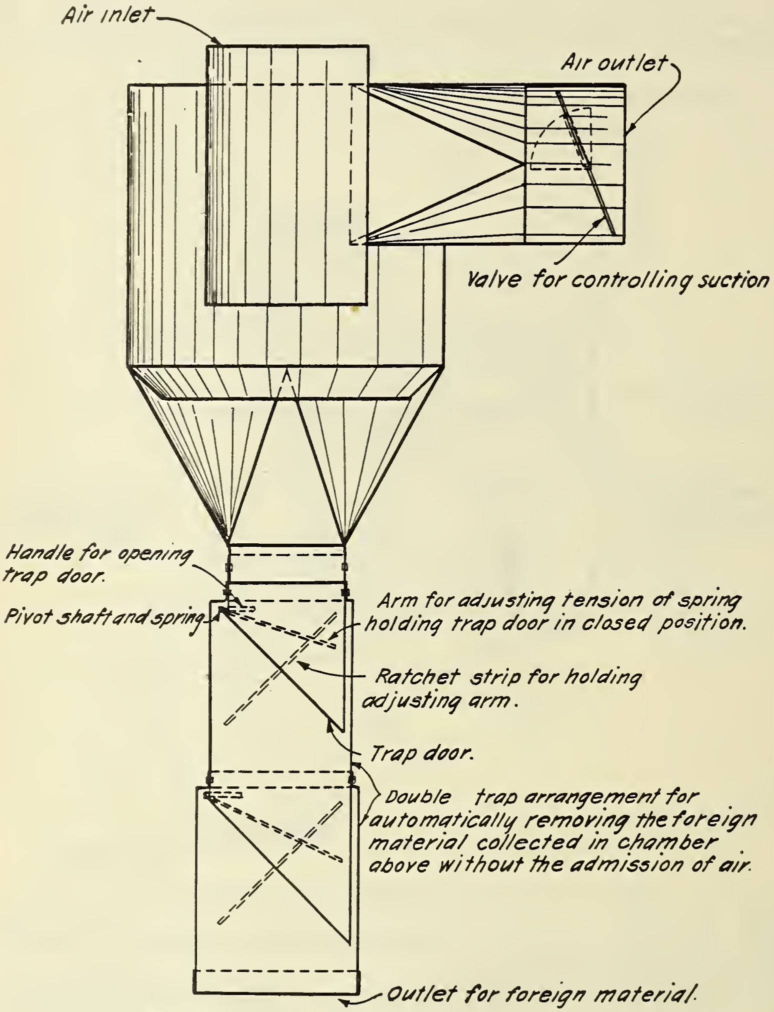
Air inlet
Air outlet
Valve for controlling suction
Handle for opening trap door.
Pivot shaft and spring
Arm for adjusting tension of spring holding trap door in closed position.
Ratchet strip for holding adjusting arm.
Trap door.
Double trap arrangement for automatically removing the foreign material collected in chamber above without the admission of air.
Outlet for foreign material.

FIG. 6.—Cross section of the expansion chamber for collecting the foreign material removed from the grain

It is flexible in arrangement.—The aspirator head will usually be located where the stream of grain leaves the thresher grain elevator. The location of the expansion chamber or dockage-collector chamber and the fan location are subject to considerable flexibility, although it is highly desirable to have an arrangement that requires a minimum amount of piping and few turns in the pipe. This flexibility is very important in applying a thresher grain cleaner to the various types and makes of threshing machines.

It is adaptable.—The aspirator uses only air suction for the cleaning medium; therefore it is suitable for cleaning any kind of grain with no change whatever in the equipment. By a simple adjustment of the air-suction valve the cleaning is adjusted to the conditions of the grain and dockage encountered and the degree of cleaning desired.

Most grain-cleaning machinery when once set for cleaning a certain grain can not readily be adjusted to a sudden change of grain or a sudden change of conditions. The Bates aspirator may be adjusted through its entire range of cleaning, from the heaviest to the lightest suction, by simply changing a throttle or damper in the suction pipe. This flexibility in cleaning is most desirable for producing the highest market value of grain, as the cleaning can readily be adjusted to any sudden changed condition which may occur in the grain being threshed. Occasionally grain is threshed so clean that it is neither necessary nor desirable for commercial purposes to remove any of the foreign material it contains; in such cases the suction may be entirely shut off. Often the farmer wishes to retain the cracked and shriveled wheat on his farm for feed, or he may want to get his seed wheat from a certain area of his field. In these cases the suction may be applied strongly, leaving only the plumpest and heaviest wheat in the stream.

The changing rate of feed always encountered by a machine attached to a threshing machine would interfere with the thorough cleaning of the grain by most commercial cleaners. The aspirator is only very slightly affected by the varying rate of threshing.

It will not clog.—One of the cardinal principles to be remembered in designing a thresher grain cleaner is that under no condition should the grain cleaner be the cause of a shutdown of the threshing machine. Ample provision is made so that the grain will always flow freely through the aspirator whether or not the suction is applied. Thus the possibility of interfering with the thresher operation is avoided.

It requires only a moderate amount of power.—The amount of power available for driving a threshing machine is frequently only slightly greater than the maximum demand of the thresher. Any attachment added to the threshing machine means an increase in its power requirements, and there is danger of overloading the power plant if the attachment requires any considerable amount of additional power for its operation. The suction fan for this thresher grain aspirator requires only about 2 horsepower to operate it at the speed and pressure prescribed, and it requires less power for operation when a large quantity of grain is being cleaned than it does when cleaning a small quantity. This difference in power required is not large, but the tendency is favorable if the fan requires less power when the threshing machine makes its heaviest demands on power.

Sometimes surprising results occur in the removal by air of dockage consisting largely of very fine seeds like mustard. It would seem entirely reasonable to expect that practically a perfect separation of mustard seed from wheat might be accomplished by the use of air, because of the great difference in the size of the mustard seed and the wheat; but experience has shown that it is almost impossible to separate all of the fine mustard seed by the use of air. This may be explained by the fact that, in the wake of every falling kernel of wheat, there is probably a small eddy of air which follows the kernel in its fall. If a mustard seed happens to be drawn into one of these eddies, it undoubtedly follows the wheat kernels through the air suction without being removed.

LIMITATIONS OF ASPIRATOR

The aspirator is most effective in the removal of light, irregularly-shaped seeds and foreign material, because the air can more readily lift such particles. The aspirator is least effective in the removal of heavy, smooth, round, or oval-shaped seeds. It is practically impossible to remove from wheat by air the seeds of most varieties of vetch, as they are so nearly the size, shape, and weight of the wheat kernel.

RESULTS OBTAINED BY ASPIRATOR

From the analysis of the samples of grain and dockage taken at threshing machines equipped with aspirators a wide variety of results have been obtained. It seems reasonable to conclude that at its present state of development an average efficiency of about 50 per cent in the removal of average foreign material and dockage may be expected. In special cases this figure has run much higher; and, of course, when the wheat had a small dockage content it was economical to reduce the suction and the consequent efficiency. The test weight per bushel of wheat was, on an average, raised about one pound per bushel by the use of the aspirator. In some lots of wheat cleaned with the aspirator the test weight of the grain was raised over one pound per bushel. Recent tests indicate that approximately one-third of the smut dust and smut balls are removed from the wheat by the aspirator.

HOW TO OBTAIN AN ASPIRATOR

Plans and specifications for the Bates aspirator may be obtained by writing to the United States Department of Agriculture. With these plans and specifications any manufacturer may build the aspirators for sale. Threshermen may obtain these plans and specifications and have the aspirators and dockage collectors built by their local tinners or they can be purchased complete from sheet-metal companies, the address of whom may be obtained upon request from United States Department of Agriculture, Washington, D. C.

INSTALLATION OF ASPIRATOR ON STATIONARY THESHER

Instructions for installing the aspirator on each of the various makes and types of threshing machines are impossible here, but general principles and illustrations can be given by showing and describing the installations which have been made by the Government in its experimental work. Knowing the general requirements, each thresherman can use his own best judgment in applying the aspirator to his thresher.

The aspirator head occupies a vertical space of approximately 2 feet. It is necessary to provide this additional 2 feet of space at some point where the grain is falling. This can usually be accomplished by extending the grain elevator about the amount of space needed and inserting the aspirator head in the opening. This is well illustrated in Figures 4 and 7. The extension of the elevator is marked in Figure 7 as gg, which provides space for the aspirator head to be inserted between the cross conveyor and the head of the elevator. With machines having a weigher it would seem desirable to insert the aspirator above the weigher, as the stream of grain would be more uniform at that point; but this means that the grain would be cleaned before being weighed, and unless some just compensation could be made for threshing the material removed from the wheat such an arrangement might be open to objection by the threshermen.

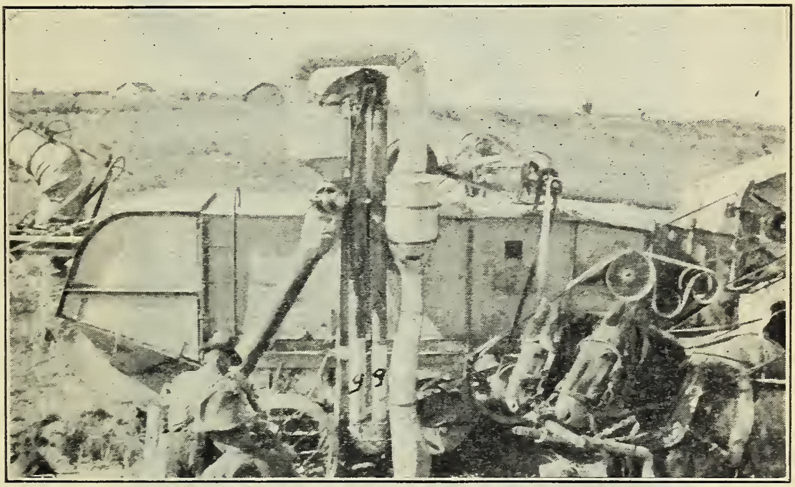

FIG. 7.—A Bates aspirator installed on rice thresher at Willows, Calif.

In the case of a high elevator it will usually not be necessary to extend the elevator to a greater height; but if 2 feet of its effective height is used by inserting the aspirator this will have some effect on the position of the baggers, receiving bins, or wagons. The aspirator head attached to a high elevator is illustrated in Figure 8. No difficulty was experienced with this machine on account of the reduced slant height of the grain spout, but this machine was not equipped with a weigher. If the weigher is attached in addition to the aspirator, care must be taken not to reduce the slant of the grain spout to the point where the grain will not flow freely.

In the installation shown in Figure 7 the logical location for the dockage collector was just back of the elevator as shown. In this position it did not interfere with any of the normal thresher operations, and it was convenient to pipe from the aspirator directly over the head of the elevator and straight down into the dockage collector. This location also provided a convenient place to receive the dockage.

A dockage collector of the same type, used on the high elevator machine, is shown in Figure 9. The location of the dockage collector is more or less flexible, but it should be located at a point convenient for connection to the fan and to the aspirator head. Figure 10 shows the connection between the dockage collector (*b*) and the suction fan (*c*). The installation shown in this picture could have been improved by raising the dockage collector so that the connection from the dockage collector to the fan would have been a straight pipe.

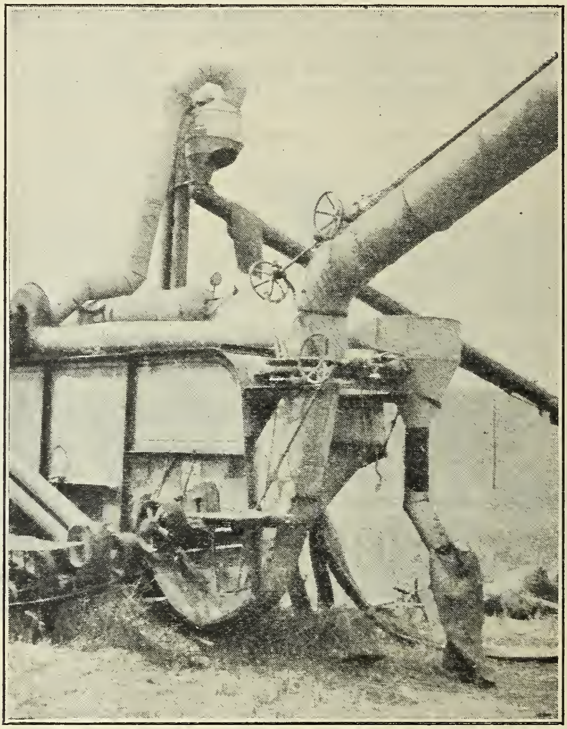

FIG. 8.—Bates aspirator installed on wheat thresher at Farmington, Wash., showing a cyclone type of dockage collector

The exact location of the suction fan is not rigidly prescribed, but it should be located at a point convenient for attaching to the dockage collector (*b* in fig. 10), bearing in mind the necessary mechanism for driving the fan. Figure 10 shows a fan driven by means of a jack shaft. The shaft is supported by two inverted standard shaft hangers. The jack shaft was driven from a pulley on the shaker shaft shown in Figure 7. The method of driving the fan on the machine with a high elevator is shown in Figure 11. This thresher was equipped with a smut-dust removing fan (*a* in fig 11) in addition to the aspirator. The shaft of the smut fan was extended through the casing of the fan inlet, an outside bearing was provided and a pulley was attached from which the aspirator fan (*c* in fig. 11) was driven. The discharge from the fan in Figure 11 is carried to the rear of the machine, where a small cyclone collector separates the dockage from the air and the dockage falls into a bag. (See fig. 8.) The objection to this particular installation is the amount of air resistance caused by the length of piping. Unless the "cyclone" can be located much nearer the fan than in this case it would not be desirable to use this collector on such a machine.

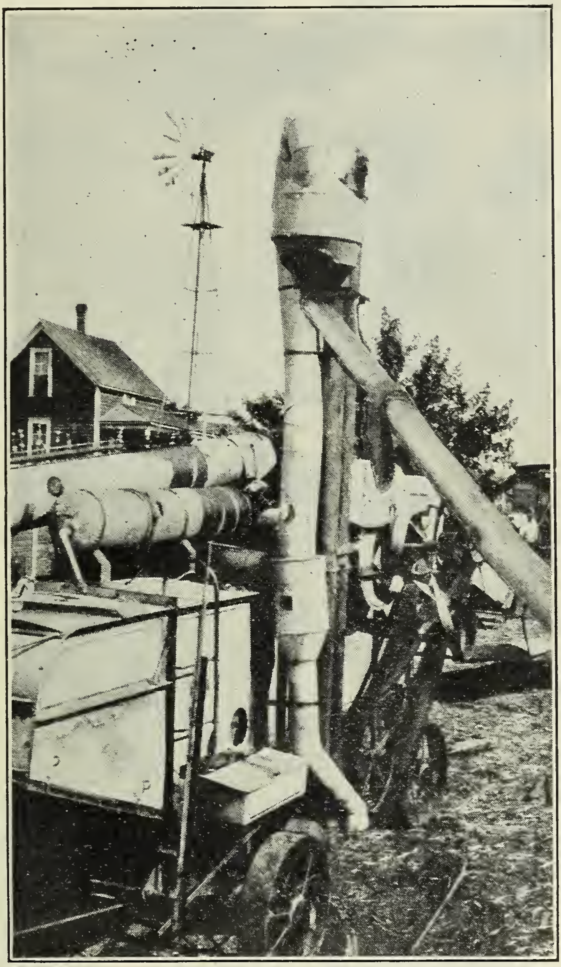

Fig. 9.—Bates aspirator equipped with expansion type of dockage collector attached to thresher with high elevator. (Note.—This threshing machine is also equipped with a smut-dust-collecting fan and with a fire extinguisher, both of which are located on the deck of the separator.)

The same machine provided with a dockage-collecting chamber is shown in Figure 9.

This machine, on which the aspirator was installed, was equipped not only with a smut-suction fan but with a fire extinguisher placed on top of the deck for protecting the machine from fire resulting from smut-dust explosions. Reference is made here to these other attachments in order that no one will assume that all of the extra equipment shown in Figures 8, 9, and 11 belongs to the grain aspirator.

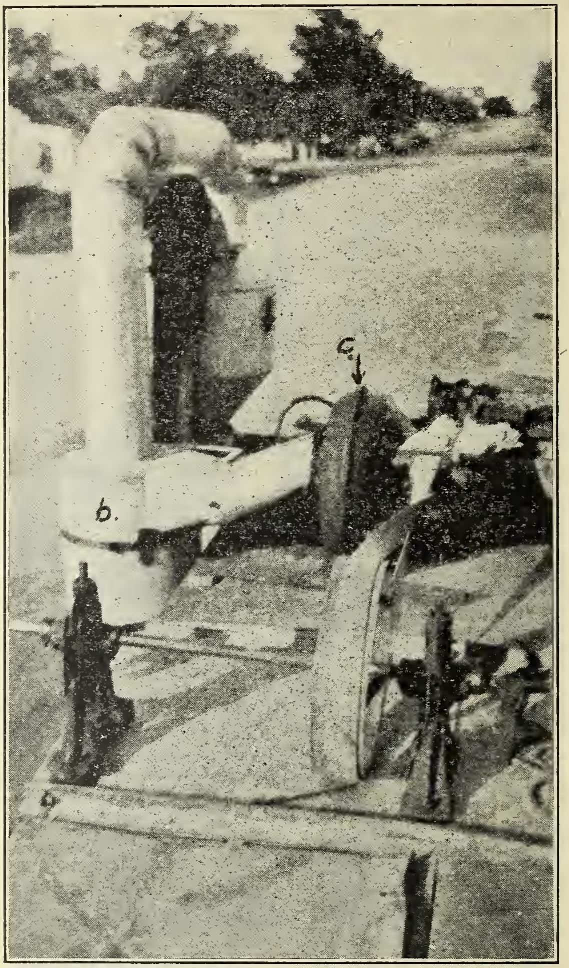

FIG. 10.—View from the forward part of deck of a rice-threshing machine, showing aspirator head, dockage collector, suction-fan, driving shaft, and pipe connections for the dockage collector

INSTALLATION OF ASPIRATOR ON COMBINE

The inserted section of a combine elevator to make room for the aspirator is shown at *a* in Figure 12. The rotary grain cleaner, which is a part of the regular attachment of the combine indicated at *b*, retained its position relative to the elevator head. After passing through the rotary cleaner the grain drops into the grain aspirator, where it is cleaned, and flows to the sacking platform, which remains in its original position. In this installation it was necessary to build a supporting platform for the fan, as shown in the picture. The fan was so located that a belt from its pulley would run tandem over the drive belt of the combine. The discharge from the fan which carried the removed dockage was conducted back into the body of the combine.

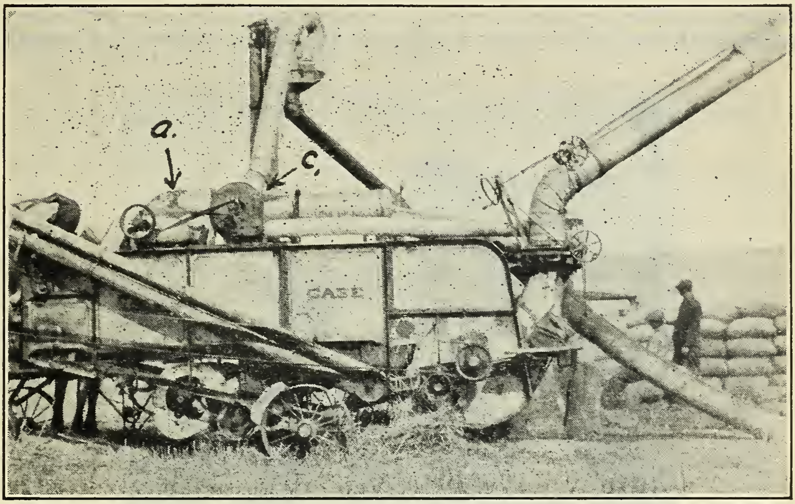

Fig. 11.—The drive side of thresher, showing means of driving suction fan for aspirator and piping of the cyclone dockage collector at rear of machine

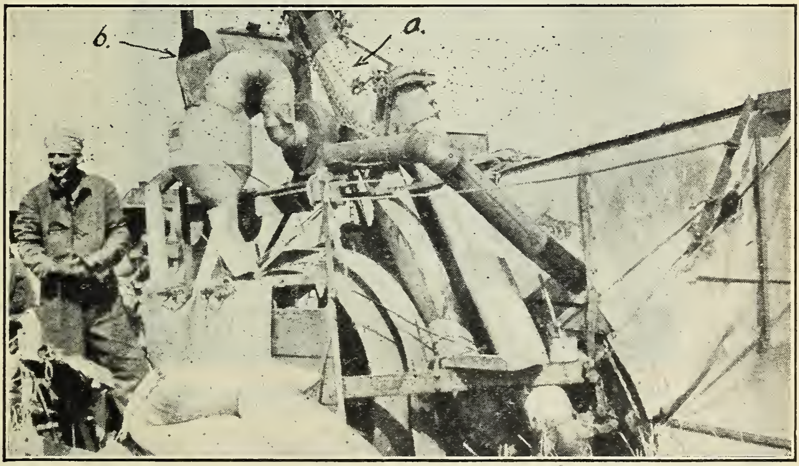

Fig. 12.—A Bates aspirator installed on combine harvester at Goldendale, Wash., showing connection for discharging dockage back into the combine

Later this machine was equipped with a cyclone dockage collector, as shown in Figure 13. The material thus collected was run into the tailings elevator as shown in the picture. It was not desirable to run the material collected by the aspirator into a bag, as the sack sewer did not have time to take care of it, so it was returned to the machine for rethreshing. If a rather light suction were used on the grain and only chaff, straw, and straw knuckles were removed it would doubtless be desirable to discharge the material on the ground instead of into the machine, but when some wheat and portions of unthreshed heads are removed the arrangement shown is desirable.

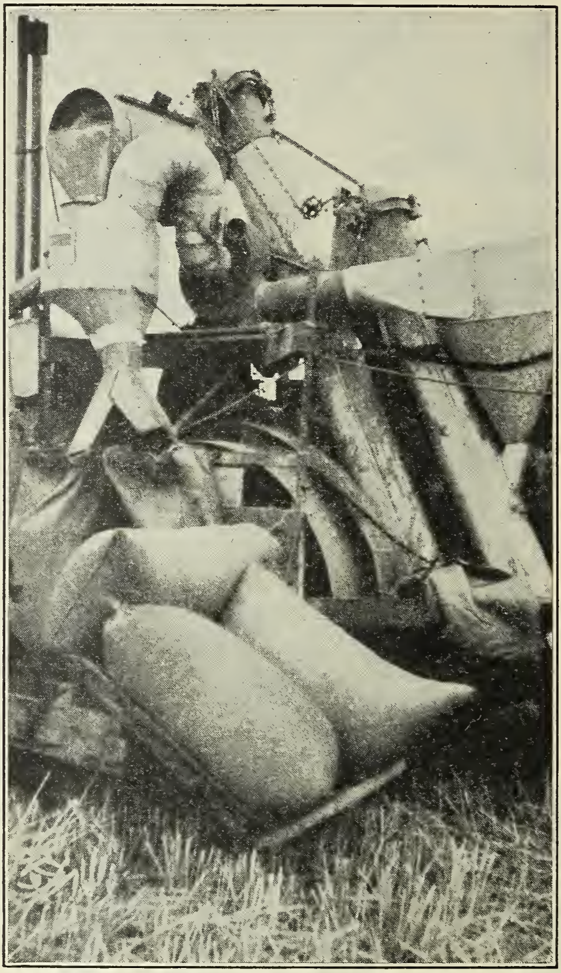

FIG. 13.—Combine equipped with cyclone dockage collector for returning the dockage to the tailings elevator

The fan used by the Department of Agriculture in its experimental work was an exhauster of standard make and the following specifications: Height, 22⅝ inches; total width, 19⅛ inches; diameter of blast wheel, 12¼ inches; diameter of shaft, 1 inch; diameter of drive pulley, 4⅜ inches; length of face pulley, 3¼ inches; outside diameter of intake, 7½ inches; outside diameter of discharge opening, 7½ inches. This fan driven at a speed of 2,490 revolutions per minute will deliver 1,260 cubic feet of air per minute at a pressure of

1 inch of water, and requires 1.45 horsepower. At the same speed if the pressure were increased to 3 inches of water the fan would deliver 946 cubic feet of air and the power required would be cut down to 0.98 horsepower. The fan case is of cast iron. The fan will withstand a safe maximum speed of 4,050 revolutions per minute and weighs 130 pounds. This fan now costs at the factory $65, and if equipped with ball bearings costs $75.

A fan with a pressed steel case would be cheaper and lighter and with approximately the same characteristics would be suitable for use with the aspirator.

It is very important that the speed of the fan be sufficiently high to provide ample suction. Ample suction is a suction strong enough to lift kernels of plump wheat when the throttling damper is fully open. It is not desirable to run the fan greatly in excess of this required speed. It has been found by the Department of Agriculture that approximately 2,500 revolutions per minute is a satisfactory speed for the ordinary installation. The more the resistance to the passage of air caused by small diameter pipes, long pipes, and sharp turns in the pipes the higher will be the speed at which the fan should run and the greater will be the power required to drive the fan.

Certain points must be borne in mind by anyone installing an aspirator on a threshing machine.

(1) The piping that connects the parts should be kept large in diameter. All pipes should be kept as short in length as possible. Careful study should be given the location of parts on the thresher to avoid unnecessary turns in the pipe.

(2) If possible the fan should be driven direct from the cylinder shaft without a jackshaft. This arrangement conserves power and lessens the cost of installation.

(3) The suction control should be at a convenient point so that the change in suction for varying field conditions can be easily made.

(4) Care should be taken to see that the stream of grain flowing over the edge of the distributing cone is uniform. A stream of grain that is thick on one side of the cone and thin on the other side will mean unsatisfactory operation of the aspirator.

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